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ABSTRACT

This research attempted to replicate and extend results from a previous study examining the effects on achievement of generating summaries or analogies while reading a lengthy text. Before the study, 111 undergraduate students from a large midwestern university were classified as high or low ability and randomly assigned to paired or individual conditions and to one of three experimental treatments: (1) a summaries group; (2) an analogies group; or (3) a control group. Subjects read a 6,300 word chapter about marine life and a posttest was administered to measure literal comprehension. Posttest achievement was higher for students who generated summaries (mean=21.41) than for students who generated analogies (mean=17.75). Furthermore, a significant interaction indicated that high ability students learned more effectively studying alone (mean=25.47) than in pairs (mean=18.55). Reasons for the ineffectiveness of the paired treatment are discussed. Results of the data analyses are presented in three tables. (3 notes, 22 references) (Author/BBM)

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Generative Learning in Small Groups

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AECT , 1992

Abstract

This research attempted to replicate and extend results from a previous study examining the effects on achievement of generating summaries or analogies while reading a lengthy text. Before the study, 111 students were classified as high or low ability and were randomly assigned to paired or individual conditions and to one of three experimental treatments: a summaries group; an analogies group; or, a control group. Posttest achievement was higher for students who generated summaries (mean =21.41) than for students who generated analogies (mean = 17.75). Furthermore, a significant interaction indicated that high ability students learned more effectively studying alone (mean = 25.47) than in pairs (mean = 18.55). Reasons for the ineffectiveness of the paired treatment are discussed.

Generative Learning in Small Groups

Students often read instructional texts superficially resulting in poor recall and transfer. Generative learning attempts to improve learning from text by providing students with methods that stimulate deeper processing (Wittrock, 1990). Generative learning emphasizes forming relations among information to be learned and between the information and the learner's knowledge and experiences.

In a recent study, Wittrock and Alesandrini (1990) examined the effects of three processing strategies on students' ability to comprehend and retain information from text. After reading each paragraph of a text, students employed one of two generative learning techniques (summarizing each paragraph's main idea or writing an analogy associating the text with the reader's personal knowledge base) or simply re-read each paragraph. Students who generated analogies or summaries demonstrated higher posttest achievement than did students who re-read the text, but no differences were found between the generative treatments.

Although achievement differences for the two generative activities were not different, data indicate that students were more facile generating summaries than analogies. During the treatments, students generated appropriate summaries with 99% success and analogies with 75% success. These data suggest that generating analogies is more difficult than generating summaries. Moreover, difficulties generating analogies may have suppressed students' posttest achievement. Learning for the analogies treatment may have improved if students had generated more effective analogies.

Content organizing and integrating activities may be more effective when working with a partner rather than alone. Although studies have focussed on learners working individually, generative learning may be more effective in groups. The cognitive effects of working in small groups are well established. A meta-analysis comparing group with individual learning produced an effect size of .63 favoring grouping (Johnson & Johnson, 1989). Furthermore, in a study comparing the effects of summarizing text individually or in groups, students who generated summaries in dyads learned more than students who generated summaries alone (O'Donnell et al.,1987). Students often learn more effectively in an environment that provides opportunities to share information and engage in constructive conflict.

Generating analogies in small groups may also stimulate learning. Difficult tasks are often solved more effectively in small groups than when working alone (King, 1989). However, two important questions exist concerning the formation of a group analogy. First, can collaborating students create more effective analogies than students working alone? Second, can an analogy formed by consensus improve learning? Cooperation may deepen processing and improve recall for both partners. Alternatively, a group analogy may furnish information that benefits only

one partner or is not particularly useful to either group member (Dansereau, 1987). In such cases, group learning may be no more, and potentially less, effective than studying alone.

The purposes of the present study were to replicate and extend Wittrock and Alesandrini's (1990) study. We investigated the effects of using generative learning techniques to learn from text while studying alone and in small groups. Furthermore, we examined whether students working in groups generated more effective summaries and analogies during instruction than did students working alone.

Method

Subjects

A sample of 111 undergraduate students from a mid-western university completed the study. Students received extra course credit in computer-science for participating.

Materials

Pretests. The purpose of the pretest was to measure verbal-analytic ability. Verbal-analytic ability was measured with the Similarities Subtest of the Weshsler Adult Intelligence Scale[1] (WAIS) (Wechsler, 1958). Students were classified as high or low ability according to pretest performance. High ability students scored above the mean and low ability students scored below the mean on the pretest. The mean score for the high ability students on the pretest was the 73rd percentile and mean for the low ability students was the 53rd percentile.

Text. Subjects read a 6,200 word chapter about marine life[2]. The text, which was the same as that used in several previous research studies, was originally selected for its high imagery content and was intended to stimulate imagery processing. After each paragraph students were referred to an answer booklet. The answer booklet contained the instructions for each treatment.

Posttest. A 68-item posttest measured literal comprehension. A typical posttest question is: "A hydrophone network set up by the Navy to protect (Chesapeake) Bay during World War II was temporarily made useless by noise made by fish." Since the original 72 item posttest was unavailable, the posttest was constructed from items provided by Dr. Ernst Rothkopf[3]. The KR-21 reliability for the posttest was 0.74.

Summaries and analogies. The summaries and analogies generated during the experiment were analyzed to determine the degree to which students followed instructions during the experiment. These scores were analyzed further to determine the extent to which the experimental treatments influenced posttest achievement. Each analogy or summary generated according to directions provided during the experiment scored two points. An analogy or summary which only partially complied with directions scored one point. Other generations did not receive a point. An example of a student generated summary is: "Sperm whales go deep down in the ocean to feed on animal life. Squids inhabit this region also." An example of a student generated analogy is: "Sir John Ross has shown proof that there is some form of life 'worms' at a depth of 1000 fathoms. Not too surprising--worms like a dark wet environment."

Design

The study employed a 2X2X2 factorial design with two appended control groups. The factors included Grouping (Individuals, Pairs), Treatment (Summary, Analogy), and Ability (High, Low). In one control group students studied alone and read each paragraph twice before continuing to read the passage. In the other control group students studied in pairs and recorded comments to learn as much as possible from each paragraph, but were not directed how to interact or as to the nature of information to record. Dependent measures included posttest achievement and time on task. Also, students in the analogies and summaries treatments received scores for writing produced during the experiment

Procedures

The pre-test was completed approximately one week before the study. Prior to the experiment, students were randomly assigned to work individually or in pairs, and to one of two treatment groups or two control groups resulting in six analysis groups (Individual summary, Individual analogy, Individual re-read, Paired summary, Paired analogy, Un-scripted pairs). Students working alone received identical instructions to those provided in a previous study (Wittrock & Alesandrini, 1990). All students were instructed to record the start and finish time of the experiment. Students assigned to the Summary treatment were instructed to read and review a paragraph of text and then to summarize each paragraph in a space provided in an answer booklet. A summary was described as consisting of one or two sentences that state the main idea or topic of a paragraph. Students were asked not to copy sentences directly from the passage, not to use any terminology from the paragraph, and to write the sentences in their own words.

A similar statement was provided for students in the analogy treatment. Students were asked to review each paragraph and to write an analogy associating the content from the text with things that students already knew about. An analogy was described as consisting of one or two sentences which clearly related the new ideas to familiar things or experiences.

Students in the re-read treatment were instructed to record the time before, and again upon completing, reading each paragraph. After recording the finish time, students were instructed to re-read each paragraph. Students were also informed that the experiment was not examining speed reading and that recording the time helped to fulfill an important experimental condition.

Students assigned to the paired Summary and Analogy treatments received identical instructions to the corresponding individual treatments, together with instructions to work together to form analogies/ summaries for each paragraph, to share ideas and experiences, and that each partner should write an analogy/summary individually in their answer booklets. Students working in the paired control group were instructed to work with their partner, to remember as much of the passage as possible, and to enter relevant comments into an answer booklet after reading each paragraph.

Results

Posttest Achievement

Posttest means and standard deviations are contained in Table 1. A significant difference was found for Grouping, $F(1,67)= 7.73$, $p<.01$. Students who completed the instruction individually scored higher than students who completed the instruction in pairs (means 21.73 and 17.63). A significant difference was also found for Treatment, $F(1,67)= 4.75$, $p<.03$. Students who completed the Summary treatment scored higher than students who completed the Analogy treatment (means 21.41 and 17.75). A significant interaction was found between Ability and Grouping, $F(1,67)= 5.10$, $p<.03$. The interaction is shown in Figure 1. Follow-up comparisons indicated that the achievement scores for high ability studying alone were higher than those of high ability students studying in pairs and students working alone. No statistically reliable differences were found between the treatment and control groups.

Insert Table 1 and Figure 1 About Here

Time On Task

No differences were found for time on task. However, posttest scores were divided by time on task to produce a measure of learning efficiency. This metric produced a significant difference for Grouping $F(1,67)= 12.22$, $p<.001$. The learning rate for students who completed the instruction individually was higher than for students who worked in pairs (means 0.267 and 0.200). A significant difference was also found for Treatment $F(1,67)= 4.05$, $p<.05$. Students who completed the Summary treatment were more efficient than students who completed the Analogy treatment (means 0.253 and 0.210).

Summaries and Analogies

Posttest means and standard deviations are contained in Table 2. Significant correlations were found between posttest achievement and summaries, $r(39)= .318$, $p<.05$, and posttest achievement and analogies, $r(36)= .373$, $p<.05$. Further analyses investigated the quantity generated individually and in pairs. Separate independent t-tests were used to examine the quantity of analogies and summaries generated in paired and individual treatments. Analysis of the summaries produced a significant difference for Grouping, $t(37)= 2.402$ $p<0.05$. Students working alone generated significantly more summaries than students working in pairs (means 87.11 and 79.50). However, the analysis of analogies was not significant $t(34)= 0.72$ $p>0.05$. The means of students working alone (mean= 40.11) and in pairs (mean= 42.78) were not reliably different.

Insert Table 2 About Here

Discussion

Students working alone scored significantly higher on the posttest than students working in pairs. Moreover, the significant interaction between Ability and Grouping indicates that pairing impaired high ability students performance when learning from text, but did not affect the low ability students. Achievement was significantly higher for high ability students working individually (mean = 24.81) than in groups (mean = 19.04). However, achievement differences between low ability students

working alone (mean = 17.88) and in small groups (mean = 17.70) were not significant. In other words, grouping hampered only the high ability students. Furthermore, pairing reduced instructional efficiency. Individuals completed instruction significantly more efficiently than collaborators.

These results deviate from research supporting small group interventions. Most studies report significant advantages gained from collaboration. Furthermore, although some studies suggest that not all students benefit from collaboration (Webb, 1982a; Beane & Lemke, 1971), several studies support the efficacy of grouping for all ability groups. For example, two studies reported that high, average, and low ability second and third grade students demonstrated higher performance after collaborating than after working alone (Yager, Johnson, & Johnson, 1985; Yager, Johnson, Johnson, & Snider, 1986). Similarly, high, average, and low ability students demonstrated higher achievement and lower math anxiety after completing a computer-based integrated learning system in pairs rather alone (Mevarech, Silber, & Fine, 1991). Hooper (in press), also reported that high and average ability fifth and sixth grade students, working in heterogeneous or homogeneous ability groups, outperformed their counterparts working alone while completing a computer-based tutorial.

Two explanations for the present findings are suggested. First, students working in groups may have experienced the free rider effect (Kerr & Bruun, 1983). The free rider effect is a phenomenon that occurs in groups when individual effort is presumed to be unnecessary due to the perceived competence of other members. The resulting reduced effort is manifested in reduced group performance. In the present study, paired students may have invested less effort in the learning task than students working alone, relying instead on their partners to furnish the required information. This conjecture is supported, in part, by the count of the summaries generated during the experiment. Means for summaries were significantly higher for students working alone than in pairs. Further inspection reveals significant differences between high ability students' generations, but only small differences between the low ability students' generations. High ability students may have believed their partners were competent at forming effective summaries and consequently invested less personal effort in the task.

Second, students may have interacted ineffectively. Researchers generally agree that the efficacy of small group learning is linked to the nature of intra-group interaction (Webb, 1982b; Hooper, in press). Effective interaction stimulates cognitive effort which in turn mediates deeper processing (Salomon, 1984; Wittrock, 1990). However, appropriate small group interaction often does not occur naturally, and simply encouraging college students to work together may be ineffective (Carrier & Sales, 1987). Unlike school children who socialize frequently, many college students have little social contact with their class peers and may not interact effectively when asked to do so.

Another finding from the present study is that working with a partner did not help students to generate effective analogies and did not enhance posttest performance. Students in the Summary treatment demonstrated higher posttest performance and greater instructional efficiency than students in the Analogy treatment. Furthermore, means for the count of the summaries generated during instruction were more than double the means for the analogies count. Although direct comparison must be made with caution, these differences indicate that students in the Analogy treatment experienced difficulties completing their task. Means for achievement, generations, and time-on-task for each of the text processing strategies included in this and the Wittrock and Alesandrini (1990) study are included in Table 3.

Insert Table 3 About Here

The present study failed to replicate Wittrock and Alesandrini's (1990) finding that students using generative learning strategies demonstrated higher posttest performance than students who re-read a passage. Little evidence exists to explain this finding, although some differences existed in the administration of the original and the replication studies. Although both studies employed identical stimulus materials the posttest used in the present study differed from the original posttest. Also, students in the original study completed the experimental treatments in sessions of 4-6 people. In the present study, the treatments were administered in sessions of approximately 30 people.

Effective interaction may require interdependence among group members and guidance in using interaction techniques. Salomon (1989) suggested that the cognitive benefits of group learning are limited to the extent that students are interdependent and that group members must commit to common goals and agree to coordinate and invest effort in order to experience the cognitive benefits of group learning. Salomon also proposed that interdependence is likely to be low during short research studies

involving subjects with little previous interpersonal knowledge or interaction and that under such conditions small groups may be ineffective learning environments.

Future research should focus on teaching students to interact effectively in groups and to generate analogies. Without prior practice, many students are unlikely to generate effective analogies. Furthermore, research examining methods to stimulate intra-group interaction suggests that students must be guided to interact effectively. Without guidance students working in small groups often model teaching techniques that are familiar, but unrelated to group success (McKellar, 1986).

Notes

1. Weshsler Adult Intelligence Scale. Copyright © 1955 by The Psychological Corporation. Reproduced by permission. All rights reserved.
2. From The Sea Around Us, Revised Edition, By Rachel L. Carlson. Copyright © 1950, 1951, 1961 by Rachel L. Carlson; renewed 1979 by Roger Christie. Reprinted by permission of Oxford University Press, Inc.
3. The authors wish to thank Dr. Ernst Rothkopf of Teachers College, Columbia University, for supplying the test used in this study.

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Figure 1. Interaction between Ability and Grouping

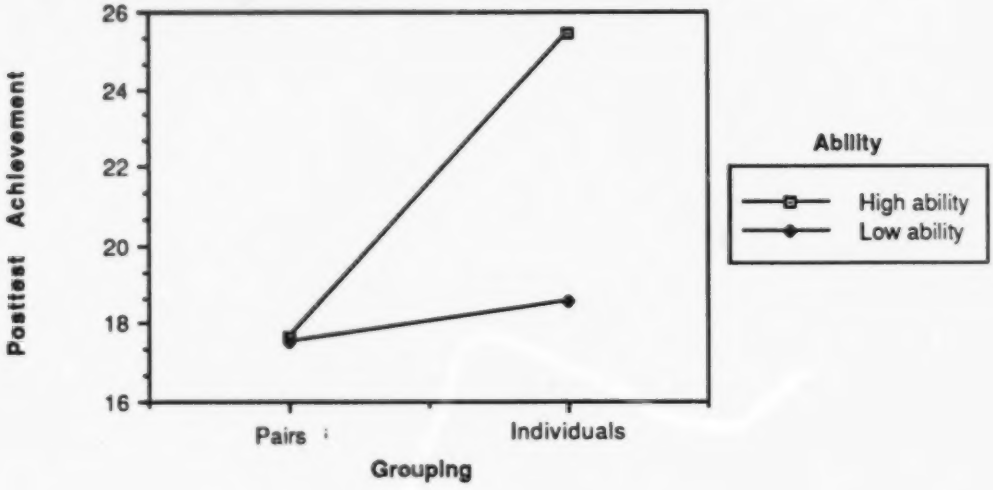

Table 1: Achievement and Time-on-task Means and Standard Deviations

Group / Ability		Posttest	Time-on-task
Individuals			
High			
Re-read	M	23.20	74.80
(n=10)	SD	9.69	11.92
Summary	M	27.00	82.40
(n=10)	SD	6.77	12.46
Analogy	M	23.29	86.43
(n = 7)	SD	6.02	14.54
Total	M	25.47	84.06
(n=17)	SD	6.55	13.07
Low			
Re-read	M	19.00	91.25
(n=10)	SD	8.70	17.02
Summary	M	19.56	88.78
(n=9)	SD	5.39	14.64
Analogy	M	17.73	80.64
(n = 11)	SD	7.63	14.68
Total	M	18.55	84.30
(n=20)	SD	6.61	14.87
Pairs			
High			
Comments	M	21.38	88.88
(n=10)	SD	8.11	13.95
Summary	M	19.15	83.62
(n=13)	SD	6.49	9.24
Analogy	M	15.56	90.22
(n = 9)	SD	6.19	18.75
Total	M	17.68	86.32
(n=22)	SD	6.48	13.92
Low			
Comments	M	18.50	85.10
(n=10)	SD	9.11	8.39
Summary	M	20.00	90.14
(n=7)	SD	6.88	13.23
Analogy	M	15.67	95.22
(n = 9)	SD	6.60	21.78
Total	M	17.56	93.00
(n=16)	SD	6.86	18.16

Table 1 (cont): Main Effects Summary

		Posttest	Time
Group			
Individuals (n=37)	M	21.73	84.19
	SD	7.37	13.87
Pairs (n=38)	M	17.63	89.13
	SD	6.55	15.97
Ability			
High (n=39)	M	21.08	85.33
	SD	7.52	13.43
Low (n=36)	M	18.11	88.17
	SD	6.65	16.75
Treatment			
Summary (n=39)	M	21.41	85.67
	SD	6.99	12.11
Analogy (n=36)	M	17.75	87.81
	SD	7.07	17.85

Table 2
Summary and Analogy Ratings Means and Standard Deviations

Grouping			Generation	
Ability			Summary	Analogy
Pair				
	High	M	77.6	43.6
		SD	12.8	10.24
		n	(14)	(9)
	Low	M	83.8	42.0
		SD	9.4	10.3
		n	(6)	(9)
	Total	M	79.5	42.8
		SD	12.1	9.9
		n	(20)	(18)
Individual				
	High	M	87.3	46.3
		SD	7.6	7.2
		n	(10)	(7)
	Low	M	86.9	36.2
		SD	6.4	13.4
		n	(9)	(11)
	Total	M	87.1	40.1
		SD	6.9	12.2
		n	(19)	(18)

Table 3
Means and Standard Deviations for Original and Replication Studies

	Treatments					
	Individuals			Pairs		
Learning & abilities	Read text	Generate summaries	Generate analogies	Generate comments	Generate summaries	Generate analogies
Learning (72 items)	(n=19)	(n=19)	(n=19)			
(O)Mean	22.4	29.8	27.2			
(O)SD	(9.2)	(7.7)	(6.3)			
Learning (68 items)	(n=18)	(n=19)	(n=18)	(n=18)	(n=20)	(n=18)
(R)Mean	21.33	23.47	19.89	19.78	19.45	15.61
(R)SD	(9.25)	(7.01)	(7.40)	(8.55)	(6.46)	(6.20)
Generations (100 maximum)						
(O)Mean	.	98.7	75.4			
(O)SD	.	(2.4)	(23.3)			
Generations (100 maximum)						
(R)Mean		87.12	40.11	.	79.50	42.78
(R)SD	.	6.88	12.25	.	12.06	9.99
Time to Learn (minutes)						
(O)Mean	76.1	86.3	85.2			
(O)SD	(21.6)	(18.6)	(15.3)			
Time to Learn (minutes)						
(R)Mean	82.11	85.41	82.89	86.78	85.90	92.72
(R)SD	(16.28)	(13.55)	(14.48)	(11.01)	(10.93)	(19.88)

Note: O represents scores from the original study. R represents scores from the replication study.